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Final Report on Contract N00014-87-K-0163 (1/1/87-5/31/89)
University of Tennessee, James K. Ho, Principal Investigator

1. Summary

The tasks accomplished as of May 31, 1989 are:

A. Implementation of DECOMPAR, a linear programming decomposition code in Fortran to run on the VAX/UNIX based CRYSTAL multi-computer at the University of Wisconsin-Madison. The results have been published [4].

B. Documentation of DECOMPAR. A large part of our computational work is based on DECOMP, a Fortran implementation of the Dantzig-Wolfe decomposition algorithm for block-angular linear programs. This code has evolved over a period of fifteen years into a robust and relatively portable experimental tool for large-scale mathematical program-ming. While it has been distributed by the PI to many researchers worldwide, comprehensive documentation was not available. This task resulted in a complete tutorial, user's guide and programmer's manual in the form of a 206-page monograph [6] to be published in the Springer-Verlag Lecture Notes Series in Economics and Mathematical Systems.

C. Analysis and empirical study of computational strategies for parallel decomposition. Results were presented at the XIIIth International Symposium on Mathematical Programming, August 29-September 2, 1988 in Tokyo, Japan. They were also described in T.C. Lee's doctoral dissertation [7].

D. The multistage, multiproduct material requirements planning problem with capacity constraints. We published results [5] that the basis in a class of linear programs arising from material requirements planning can be triangularized. This allows for efficient adaptation of the Simplex Method similar to those for network problems. It also suggests that for finite-loading (i.e. capacitated) MRP, a decomposition

approach exploiting both subproblem structure and parallel processing can be effective for handling complex problems in multiproduct, multistage, multiperiod production systems.

E. The stochastic dynamic traffic assignment problem. Previously, the PI has shown that a class of non-linear, non-convex dynamic network flow problems can be solved as a sequence of linear programs. The LP's have the staircase structure typical of time-phased problems. A generalization to the case where input traffic at the nodes are stochastic was proposed and analyzed. The results are under revision for publication [1].

F. Computing true shadow prices in linear programming. The optinal values of the dual variables in a LP are true shadow prices (marginal values) only under nondegeneracy. Otherwise, the situation is slightly more complex. Procedures to compute true shadow prices in linear programming are proposed and results are under revision for publication [3].

G. Nonprocedural impiementation of mathematical programming algorithms. Within the popular spreedsheet environment, many optimization methods can be implemented by a more direct approach than conventional computer programming. This concept has important implications in the teaching of numerical optimization as well as parallel computation using muliple processors. This task resulted in the publication [2].

2. Publications and Reports under Contract N00014-87-K-0163

1. Birge, J.R. and J.K. Ho, "The stochastic dynamic traffic assignment problem" (Under revision for TRANSPORTATION SCIENCE).

2. Ho, J.K., "Nonprocedural implementation of mathematical programming algorithms," in R. Sharda (ed.), *Impact of Recent Advances in Computer Science on Operations Research*, North Holland, New York (1989) 226-237.

3. Ho, J.K. and D. Smith, "Computation of true shadow prices in linear programming" (In revision.)

4. Ho, J.K., T.C. Lee and R. Sundarraj, "Linear programming decomposition using parallel computers," *MATHEMATICAL PROGRAMMING* 42 (1988) 391-405.

5. Ho, J.K. and William McKenney, "Triangularity of the basis in linear programs for materials requirements planning" *OPERATIONS RESEARCH LETTERS* (1988) 273-278.

6. Ho, J.K. and R.P. Sundarraj, *DECOMP: an Implementation of Dantzig- Wolfe Decomposition for Linear Programming*, (monograph to be published by Springer-Verlag, New York).

7. Lee, Tak C., "Distributed optimization of linear programs using Dantzig-Wolfe decomposition", Doctoral dissertation, University of Tennessee, December1988.

8. Sundarraj, R., "Documentation of DECOMP: a Dantzig-Wolfe decomposition code for linear programming," Master's thesis, University of Tennessee, 1987.